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Field efficacy of different newer insecticides against shoot and fruit borer (*Leucinodes orbonalis*) on brinjal (*Solanum melongena*)

Madhup Kumar Chandan, AK Awasthi, RKS Tomar, A Kerketta, Deepak Chandravanshi and Aiswarya Ray

Abstract
The experiment was conducted during 2017-18 at BTC CARS, Bilaspur (IGKV), Chhattisgarh to evaluate the bio-efficacy of newer insecticides against brinjal shoot and fruit borer under field condition. Seven insecticides *viz.* Flubendiamide 39.35% SC @ 50 g. a.i. ha^{-1}, Chlorantraniliprole 18.5% SC @ 40 g. a.i. ha^{-1}, Spinosad 45% SC @ 73 g. a.i ha^{-1}, Cartap hydrochloride 50% SP @ 500 g. a.i. ha^{-1}, Indoxacarb 14.5% SC @ 75 g. a.i. ha^{-1}, Cynatraniliprole 10.26% OD @ 90 g. a.i. ha^{-1}, Emamectin Benzoate 1.9% EC @ 11 g. a.i. ha^{-1} were selected for the purpose. Flubendiamide was found most effective treatment against shoot and fruit borer (*Leucinodes orbonalis*), as it was recorded lowest fruit damage (29.53%) followed by Cynatraniliprole (32.51%), Chlorantraniliprole (35.11%), Cartap hydrochloride (37.60%), Indoxacarb (39.03%), and Spinosad (39.44%). The maximum fruit damage (46.33%) was recorded in Emamectin benzoate, hence, declared the least effective treatment. Flubendiamide was found most effective insecticide against shoot and fruit borer, as it was recorded lowest fruit infestation along with highest healthy fruit yield (1,805.82 q ha^{-1}) with benefit cost ratio of 1:5.73.

Keywords: *Leucinodes orbonalis*, bio-efficacy, fruit damage, newer insecticide, Flubendiamide

1. Introduction
Vegetable farming has an important place in Indian agriculture due to their nutritional, medicinal and land commercial value (Choudhary, 1977) [4]. It occupies 2-5 per cent of the total cropped area in the country. Amongst the vegetables, brinjal or eggplant (*Solanum melongena* Linn.) is a native of India. Brinjal or eggplant is worldwide known as aubergine or guinea squash which is most popular and principle vegetable crop hence regarded as "king of vegetables". Brinjal is third most widely grown vegetable species in Asia.

India is the second largest producer of vegetable with 1,05,63,000 tones production after China with production of 2,45,01,936 tones (Anonymous, 2010) [1]. The area under brinjal cultivation in India is 711.3 thousand hectares with estimated annual production of 13,557.8 thousand metric tonnes with a productivity of 19.1 metric tonnes per hectare (Anonymous, 2014) [4]. In Chhattisgarh, brinjal is grown in an area of 35,173 hectare, with an annual production of 6,42,335 metric tonnes and productivity of 18.26 metric tonnes of fruits per hectare which is less than the national average (Anonymous, 2017) [3].

The brinjal shoot and fruit borer, *Leucinodes orbonalis* Guenee is the most destructive and the major limiting factor in quantative as well as qualitative harvest of brinjal fruits and reported to cause yield losses from 37 to 93% in various states of India (Mall *et al.*, 1992) [8]. The conventional insecticides *viz.* organophosphates, synthetic pyrethroids and carbamates are generally used to control this insect. Intensive use of chemicals has led to the development of high level of insecticide resistance to a number of conventional insecticides in *L. orbonalis* (Rahman, 2007) [9]. However, growing concerns about the harmful residues in food, effects on non-target organisms and development of insecticide resistance have necessitated the development of new selective and environmentally safer molecules (Kodandaram *et al.*, 2015) [5].

2. Materials and Methods
The field experiment was conducted in the horticultural research field at BTC CARS, Bilaspur (C.G.) during *Rabi* 2017-18 in randomized block design, replicated thrice with seven

insecticide treatments along with an untreated control (Table 1). The brinjal (var. VNR-212) was planted in a plot size of 4.2×2.7 m^2 with spacing of 70 cm × 45cm, following all improved recommended package of practices during last week of October, 2017. The insecticides were applied with the help of knapsack sprayer at economic threshold level (ETL) of 5% shoot damage and 10% fruit damage. (Shirale *et al.*, 2012) [11]. The observations were recorded from ten randomly selected plants from each plot on 1 day before and 7,14,21 days after each spray for fruit infestation. The per cent fruit infestation was recorded after each picking by counting total number of healthy and damaged fruits along with the healthy and damaged fruit yield from each plot, separately. (Mahata *et al.*, 2014) [7].

Table 1: Details of different newer insecticides

Sl. No.	Chemical name	Formulation	Chemical Group	Dose (g.a.i./ha)
01	Flubendiamide	39.35%	Diamide	50
02	Chlorantraniliprole	18.5% SC	Diamide	40
03	Spinosad	45% SC	Spinosyn	73
04	Cartap hydrochloride	50% SP	Nerestoxin Analogues	500
05	Indoxacarb	14.5% SC	Oxadiazine	75
06	Cynatraniliprole	10.26% OD	Diamide	90
07	Emamectin Benzoate	1.9% EC	Abamectin	11

3. Results and Discussion

It is evident from the overall fruit damage (Table 2) that Flubendiamide 39.35% SC @ 50 g. a.i. ha^{-1} was found most effective insecticide treatment against shoot and fruit borer (*Leucinodes orbonalis*), as it was recorded lowest fruit damage (29.53%). The second best treatment was Cynatraniliprole 10.26% OD @ 90 g. a.i. ha^{-1} (32.51%) followed by Chlorantraniliprole 18.5% SC @ 40 g. a.i. ha^{-1} (35.11%), Cartap hydrochloride 50% SP @ 500 g. a.i. ha^{-1} (37.60%), Indoxacarb 14.5% SC @ 75 g. a.i. ha^{-1} (39.03%), and Spinosad 45% SC @ 73 g. a.i ha^{-1} (39.44%). Emamectin benzoate 5% SG @ 11 g. a.i. ha^{-1} was observed least effective treatment as compared to other as, it was observed maximum fruit damage (46.33%). The present findings with regard to the efficacy of Flubendiamide 39.35% SC against the pest are in conformity with the results of Mahata *et al.*, (2014) [7] and Latif *et al.*,(2010) [6].

The finding on overall healthy yield per plot shows a significant difference among the various treatments (Table 3), ranged between 1,454.49 to 1,805.82 q/ha as against lowest fruit yield (1,147.31 q/ha) in untreated control). The maximum healthy fruit yield (1,805.82 q/ha) was recorded in Flubediamide treatment.

The economics of different insecticide treatments based on net profit and total cost of cultivation (Table 4) showed that Flubendiamide 39.35% SC @ 50 g. a.i. ha^{-1} had calculated highest B:C ratio i.e. 1:5.73 followed by Indoxacarb 14.5% SC @ 75 g. a.i. ha^{-1} (1:4.97), Cynatraniliprole 10.26% OD @ 90 g. a.i. ha^{-1} (1:4.75), Chlorantraniliprole 18.5% SC @ 40 g. a.i. ha^{-1} (1:4.74), Cartap hydrochloride 50% SP @ 500 g. a.i. ha^{-1} (1:4.50), Spinosad 45% SC @ 73 g. a.i ha^{-1} (1:4.478) and Emamectin benzoate 5% SG @ 11 g. a.i. ha^{-1} (1:4.470).

Table 2: Field evaluation of different newer insecticides against shoot and fruit borer *(Leucinodes orbonalis)* on brinjal during *rabi* 2017-18.

Tr. No.	Treatment	Dose g a.i. / ha.	Mean fruit infestation(%)								
			1st Spray				2nd Spray				Overall mean
			Before spray	7 DAS	14 DAS	21 DAS	Before spray	7 DAS	14 DAS	21 DAS	
1.	Flubendiamide 39.35% SC	50	31.67 (33.84)	7.95 (16.34)^{d}	23.30 (28.84)^{d}	40.33 (39.42)^{d}	48.33 (44.04)	27.06 (31.31)^{d}	36.15 (36.95)^{d}	42.40 (40.62)^{c}	29.53 (32.89)^{e}
2.	Chlorantraniliprole 18.5% SC	40	31.70 (34.07)	10.73 (19.07)^{cd}	28.50 (32.24)^{cd}	48.45 (44.11)^{cd}	53.69 (47.11)	32.60 (34.81)^{cd}	41.46 (40.08)^{cd}	48.88 (44.36)^{bc}	35.11 (36.32)^{cd}
3.	Spinosad 45% SC	73	27.26 (31.11)	13.36 (21.39)^{bc}	33.93 (35.55)^{bc}	52.16 (46.24)^{bc}	57.61 (49.38)	36.73 (37.30)^{c}	47.48 (43.55)^{bc}	52.93 (46.68)^{bc}	39.44 (38.88)^{c}
4.	Cartap hydrochloride 50% SP	500	29.02 (32.41)	11.10 (19.39)^{cd}	31.30 (33.93)^{cd}	48.30 (44.20)^{cd}	53.33 (46.92)	38.00 (38.05)^{bc}	47.20 (43.39)^{bc}	49.67 (44.80)^{bc}	37.60 (37.80)^{cd}
5.	Indoxacarb 14.5% SC	75	28.92 (32.37)	11.73 (19.90)^{cd}	30.60 (33.33)^{cd}	50.70 (45.40)^{c}	58.18 (49.71)	39.32 (38.82)^{bc}	47.70 (43.71)^{bc}	54.08 (47.34)^{bc}	39.03 (38.64)^{c}
6.	Cynatraniliprole 10.26% OD	90	30.43 (33.28)	9.96 (18.36)^{cd}	25.45 (30.15)^{cd}	45.86 (42.61)^{cd}	50.00 (45.00)	28.83 (38.45)^{d}	38.78 (38.51)^{cd}	46.17 (42.80)^{c}	32.51 (34.74)^{de}
7.	Emamectin Benzoate 1.9% EC	11	29.20 (32.57)	16.96 (24.22)^{b}	42.40 (40.60)^{b}	61.66 (51.78)^{b}	60.00 (50.84)	44.51 (41.85)^{b}	52.69 (46.54)^{b}	59.72 (50.61)^{b}	46.33 (42.87)^{b}
8.	*Untreated Plot*	-	32.20 (34.51)	31.35 (34.04)^{a}	58.16 (49.71)^{a}	71.86 (58.05)^{a}	66.66 (54.83)	69.73 (56.83)^{a}	75.00 (60.69)^{a}	73.00 (59.47)^{a}	63.19 (52.69)^{a}
SEm±			1.97	1.23	1.90	1.94	2.28	1.46	1.99	2.22	1.07
CD (5%)			**NS**	3.78	5.83	5.94	**NS**	4.48	6.11	6.79	3.29

Note: Figure in parentheses are angular transformed values as per ICAR WASP; **DAS**= Days after spraying.
* Similar superscript letters shows non- significant differences among different treatments.

Table 3: Healthy brinjal fruit yield and its increase over control as influenced by different insecticide treatments

S. no.	Treatment	Dose (g a.i./ha.)	Healthy fruit yield (q/ha.)	Increase in yield over control (%)
1	Flubendiamide 39.35% SC	50	1805.82	36.46
2	Chlorantraniliprole 18.5% SC	40	1552.02	26.07
3	Spinosad 45% SC	73	1496.2	23.31
4	Cartap hydrochloride 50% SP	500	1454.49	21.11
5	Indoxacarb 14.5% SC	75	1559.52	26.43
6	Cynatraniliprole 10.26% OD	90	1710.75	32.93
7	Emamectin benzoate 5% SG	11	1458.55	21.33
8	Untreated control	-	1147.31	-

Table 4: Cost of cultivation with different insecticide treatments against brinjal shoot and fruit borer

S. no.	Treatment	Healthy fruit yield (q/ha.)	Insecticide + Treatment cost (Rs./ha.)	Total Cost of cultivation (Rs./ha.)	Gross income (Rs./ha.)	Net income (Rs./ha.)	Benefit over control (Rs./ha.)	B:C ratio
1	Flubendiamide 39.35% SC	1,805.82	6,170.0	1,33,994.2	9,02,910.0	7,68,915.8	3,23,083.8	1:5.73
2	Chlorantraniliprole 18.5% SC	1,552.02	7,217.2	1,35,040.2	7,76,010.0	6,40,969.8	1,95,137.0	1:4.74
3	Spinosad 45% SC	1,496.2	8,738.0	1,36,561.0	7,48,100.0	6,11,539.0	1,65,707.0	1:4.478
4	Cartap hydrochloride 50% SP	1,454.49	4,292.0	1,32,115.0	7,27,245.0	5,95,130.0	1,49,298.0	1:4.50
5	Indoxacarb 14.5% SC	1,559.52	2,643.72	1,30,466.72	7,79,760.0	6,49,293.28	2,03,461.28	1:4.97
6	Cynatraniliprole 10.26% OD	1,710.75	20,939.0	1,48,760.0	8,55,375.0	7,06,615.0	2,60,783.0	1:4.75
7	Emamectin benzoate 5% SG	1,458.55	5,491.64	1,33,314.64	7,29,275.0	5,95,960.3	1,50,128.0	1:4.470
8	Untreated control	1,147.31	-	1,27,823.0	5,73,655.0	4,45,832.0	-	-

Labour rate per day = Rs. 273 per laborer (2 laborer required for spraying in one hectare per day),
Local mandi price* of brinjal @ Rs. 5/kg.

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